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SUBSTITUTION, PERMANENT CHANGE OF STATION AND TRAINING COST COMPARISON IN MARINE CORPS OFFICER ASSIGNMENTS: A PROTOTYPE STUDY

by

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Substitution, Permanent Change of Station and Training Cost Comparison in Marine Corps Officer Assignments: A Prototype Study

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ABSTRACT

This is a cost analysis study that attempts to show how comparisons may be made among Permanent Change of Station (PCS) cost, training cost and substitution cost. A cost formulation method is introduced in this study that helps to make comparisons among these three costs. The comparison is carried out for a segment of the Marine Corps that includes only Armor and Artillery officers and billets coded for them.

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I. INTRODUCTION

A. BACKGROUND

Officer assignment is one of the important processes in the Department of Defense. Each military service reassigns a large number of its officers to new billets every year, although each service has a somewhat different approach to carrying out officer assignments. One thing that is common, however, among all the services is the intent of maintaining the readiness level during the reassignment process. Another common feature is Congress' attention to keeping the cost of assignments as low as possible.

These fact is also apply to the United States Marine Corps (USMC) as a part of the Department of the Navy within the Department of Defense. The USMC reassigns over one third of its officers every year. Currently, officer Assignment Branch (MMOA) at Headquarters Marine Corps (HQMC) carries out officer assignments largely as a manual process.

The need to improve the readiness level of combat units and maintain it at a high level at the least possible cost contributes to the assignment process being a very complex process. This is true also because MMOA considers, in addition to matching every officer to a billet by his grade and specific expertise, the experience level of the officer, the career patterns and past performances of the officer, the family problems of the officer, and other attributes as well. Because of such complexities no computer based approach can give an acceptable solution to the assignment problem. Nonetheless, computer based models may assist detailers in allowing them to make comparisons between different assignment approaches.

Among the many costs USMC manpower managers deal with, the following three will be examined in this study:

1. permanent change of station (PCS) cost,
2. training cost,
3. substitution cost.

PCS cost includes the travel entitlements which occur during personnel moves. It has real dollar value and the USMC has budget constraints for PCS costs.

Training cost also has a real dollar value. Training cost includes expenses which are incured during the training of personnel such as material and equipment expenses. Planning for the training process should be a combination of past, present and future policy plannings because it is closely related to combat readiness. Because many of the Military Occupational Specialty (MOS) courses are offered by the other services and the USMC has limited annual allocation, planning of training courses has became more important from the USMC perspective.

Substitution cost has no easily comparable real dollar value. Substitution refers to the assignment of one officer for another among all possible officers who could be assigned. Assigning an officer of grade O2 to an O3 billet, or assigning a Field Artillery officer (MOS 0802) to a Survey and Meteorological officer billet (MOS 0803) are just two examples of substituting. Because it has no direct dollar value substitution cost is determined by the relative cost of filling a billet by substituting personnel other than a perfect fit.

A comparison of these three costs should give monitors some ideas for assignment planning. They should be able to make better assignment plans, which in turn should lead to a higher combat readiness level at the least cost.

B. RESEARCH QUESTIONS

This is a cost analysis study that attempts to show how comparisons may be made among permanent change of station (PCS) cost, training cost and substitution cost. This study tries to answer the question of how such a comparison can be utilized in the assignment of Marine Corps officers. Utilization criteria are necessary in order to maintain the combat readiness level. The trade-off between cost and readiness is an underlying issue.

C. SCOPE OF THE THESIS

This study will attempt to analyze the cost of assignment for USMC Artillery and Armor officers. This cost analysis will include a comparison of the following:

1. permanent change of station cost,
2. normal training cost,
3. substitution cost.

Normally an officer may be assigned from one duty station to another if his Primary Military Occupational Specialty (PMOS) matches the billet MOS. Yet, the same officer may be assigned to a closer Monitor Command Code (MCC) even if his

MOS is not a perfect match of the billet MOS, provided he undergoes some training prior to his new assignment. In this case his PCS cost will be less, but the USMC incurs additional cost for his training. An officer may also be assigned to a billet without appropriate training, in which case an on-the-job-training cost will be incurred by the USMC.

MOS is only one of the criteria in the assignment process. Also, attention must be paid to rank and other factors such as additional MOSs possessed by some officers. Usually an officer is assigned to a billet if his rank matches the billet grade requirement. However, an officer may be assigned to a billet even if his rank is not a perfect match. In the latter case a substitution cost must be taken into account.

In each case, a choice needs to be made as to which choice is the best for the USMC with respect to both dollar outlays and unit readiness.

This study will include only USMC artillery and armor officers and billets for cost comparison and analysis. Although the results of this study have only limited use, the method of cost formulation and analysis can be applied to the entire Marine Corps Officer Corps.

D. LITERATURE REVIEW

Some work has been done using linear programming to arrive at a least cost solution to the problem of assigning a group of officers to billets.

Russell [Ref. 1] introduced an interactive model written in APL to assist Navy assignment and placement officers in their work.

Ballew [Ref. 2] presents an analysis of the professional career development of naval aviation officers with respect to their permanent change of station movements. A network representation of both successful and unsuccessful career paths of aviation officers is presented in this study.

Liang [Ref. 3] discusses the development of an idea and a methodology to automate major aspects of the personnel assignment process and to integrate the personnel assignment and allocation processes as interdependent functions of the Navy's personnel distribution system. This work provides the theoretical underpinning necessary for the development of an operational model.

Rapp [Ref. 4] describes the design and implementation of a large-scale network optimization model for assigning United States Marine Corps officers to billets during mobilization. The network model treats officers with similar attributes as supply nodes and billets with similar attributes as demand nodes. Arcs of the network represent potential assignments between supplies and demands.

Exner [Ref. 5] presents a prototype for a decision support system which permits repeated formulation and solution of the Marine Corps staffing allocation problem under various user-controlled policy scenarios. A network formulation model is presented in this study. The network formulation model permits the adjustment of objective priorities based on the formulation of Klingman [Ref. 6].

E. BACKGROUND OF THE ARTILLERY AND ARMOR COMMUNITIES

The Marine Corps occupational system has been constructed on the concept that similar skill and knowledge requirements are grouped in functional areas, known as occupational fields, which provide for the most efficient and effective classification, assignment , and utilization of Marine Corps Personnel [Ref. 7].

1. Artillery Community

The United States Marine Corps Artillery Community is known as the 08 occupational field (OCCFLD).

Occupational field 08 (Field Artillery) includes the following four different MOS's for active duty Artillery officers:

a. MOS 0802, Field Artillery Officers

Field artillery officers command, or assist commanders, in directing field artillery units.

Requirements Prerequisites : Must complete the Field Artillery Officer Basic Course, Ft. Sill. OK.

b. MOS 0803 , Survey and Meteorological Officer.

Survey and meteorological officers formulate, coordinate, and supervise the execution of survey plans essential to the proper employment of field artillery. They also install, operate, and maintain visual and electronic weather instruments common to field artillery.

Requirements Prerequisites : Must complete the Field Artillery Target Acquisition and Survey Officer Course, Ft. Sill, OK.

c. MOS 0840, Naval Gunfire Planner.

Naval gunfire planners supervise and coordinate naval gunfire activities.

Requirements Prerequisites : Must complete the Naval Gunfire Liaison Officer Course, NAB, Little Creek, VA. or NAB, Coronado, CA.

d. MOS 0845, Naval Gunfire Spotter.

Naval gunfire spotters call for and control naval gunfire.

Requirements Prerequisites : Must complete the Naval Gunfire Spotter Course, NAB, Little Creek,and Norfolk, VA.

2. **Armor Community**

The United States Marine Corps Armor Community is known as the 18 occupational field. Occupational field 18 (Tank and Assault Amphibian) includes two different MOS's for active duty officers. These are:

a. MOS 1802, Tank Officer

Tank officer command, or assist in commanding, tank units.

Requirements Prerequisites : Must successfully complete the Armor Officer Basic Course, Ft. Knox, KY.

b. MOS 1803, Assault Amphibian Vehicle Officer

Assault amphibian vehicle (AAV) officers command, or assist commanding, AAV units.

Requirements Prerequisites : Must successfully complete the Assault Amphibian Vehicle Officer Course, Camp Pendleton, CA.

II. TERMINOLOGY AND FORMULATION

This chapter explains Marine Corps terminology that is used in the officer assignment process. Also, this chapter describes the cost formulation methods and some of the principles to be used for officer assignments in the Marine Corps.

A. TERMINOLOGY

This study will be a prototype model of the cost formulation for a portion of the officer assignments in the Marine Corps. Assignment models which may make use of such cost formulations were considered by Rapp [Ref. 4] and by Exner [Ref. 5].

In a transportation model, there is a set of supply nodes and a set of demand nodes. The officer assignment models of Rapp and Exner aggregate the officers in the USMC into supply nodes, and the officers billets into demand nodes.

In the Marine Corps each officer as well as each billet may be described by certain attributes. These attributes are used in the assignment of officers to billets. In this study, these attributes will be used for cost formulations.

The attributes to be used in the formulations are PMOS, AMOS1, AMOS2, GR, CCC which describe the supply nodes and BMOS, BGR, BCCC which describe the demand nodes. In the officer assignment models, assignments are determined by comparing the supply node attributes with the demand node attributes.

The descriptions of these attributes are:

1. Military Occupation Specialty (MOS): A four digit code representing a special job requirement or personnel qualification. For example, MOS 0802 represents Field Artillery Officers. The following MOS attributes are used to characterize officers or billets:
   a) Primary MOS (PMOS): Each officer's primary job qualification.
   b) Additional MOS (AMOS): An officer may carry up to two AMOS's that he is qualified in.
   c) Billet MOS (BMOS): A billet requirement for an officer with that PMOS or AMOS.
2. Grade (GR): The grade of the officer. The inventory data include officers with the grades of Warrant Officer (WO), O2, O3, O4 and O5. In the inventory data all WOs are grouped together and O1 and O2 officers are grouped as O2.
3. Billet Grade (BGR): The billet grade requirement for an officer of that grade.

4. Monitor Command Code(MCC): Geographical location of the Marine Corps units where the officer is currently assigned.
5. Billet Monitor Command Code (BMCC): Geographical location of the Marine Corps units where the billet is located.
6. Cost Code Center (CCC): A center map location where the officer is currently assigned. Every MCC is under one of the 63 CCC's of the Marine Corps.
7. Billet Cost Code Center (BCCC): A center map location where the billet is located.

1. General Assignment Rules in the Marine Corps

The Marine Corps has major assignment rules that help us differentiate among legitimate assignments and preferences among them. Some of these rules are as follows [Ref. 4]:

(a) Assignment of officers whose attributes completely match the billet attributes are most preferred.

(b) To assign an officer outside his MOS (PMOS or AMOS's) is undesirable, but an officer may be assigned outside his MOS without required training if the BMOS is within the same occupational field (OCCFLD) as his PMOS or one of his AMOS's. At the same time grade substitution is not allowed.

(c) To assign an officer outside his occupational field without required training is usually not allowed.

(d) An officer may be assigned outside his MOS, even outside his OCCFLD if he first gets required training.

(e) To assign an officer to a billet that is not his grade is undesirable but not as undesirable as an MOS substitution. In general, a Warrant Officer (WO) may be assigned to up to O2 billets. An officer of grade O2 may be assigned to a WO or an O3 billet. An officer of grade O3, O4, O5 may be assigned to a billet of the same grade or one grade higher.

(f) All other attributes being equal, assigning officers from the same CCC as the BCCC is preferred.

(g) There is a very slight preference in having a billet filled with an officer who has his PMOS matching the BMOS as opposed to an officer who has one of his AMOS's matching the BMOS, but only if everything else is equal between the two officers.

B. COST FORMULATION

The main purpose of this thesis is to introduce a cost formulation method for the assignment process in the Marine Corps. In this analysis the cost function is a simple additive function of three different costs. These costs are:

1. MOS Substitution Cost (C_1),
2. Grade Substitution Cost (C_2),

3. PCS Cost (C_3).

Then the total cost (TOC) is

$$TOC = C_1 + C_2 + C_3 .$$

Next each component of this cost function will be explained.

1. **MOS Cost (C_1)**

C_1 is determined by comparing the PMOS, AMOS1, and AMOS2 with the BMOS, that is, C_1 is a function of those attributes:

$$C_1 = f(PMOS, AMOS1, AMOS2, BMOS).$$

If the PMOS and the BMOS are an exact fit then a cost of zero is determined for C_1. If the PMOS doesn't fit the BMOS and one of the AMOS's fits the BMOS then a cost of $1000 is derived for C_1, because we assume that officers are more productive at their PMOS.

If the BMOS doesn't fit any one of the PMOS, AMOS1, and AMOS2, then training cost and MOS substitution cost come into consideration. At this point, the formal training cost (TRC) and on-the-job training cost (OJTC) options will be considered if at least one of the PMOS, AMOS1, and AMOS2 are within the same occupational field (OCCFLD) as the BMOS.

The total training cost (TRC) will be computed as follows

$$TRC = TC + WT * AS$$

where

TC = Estimated training cost for the MOS requirement,

WT = Waiting Time for the MOS training course,

AS = Average Salary of an officer of that grade.

The Waiting Time is established for each MOS course by considering the course duration time and the course schedule as known at the assignment time. It is the length of time needed for the officer to acquire the training in the required MOS.

This Waiting Time is estimated to be the length of time from the date of assignment to the time of completion of the MOS training course. For example, as of 1 Dec., 1987 the next available 0802 MOS course starts on 15 May, 1988 and ends on 27 Sep., 1988. Waiting Time for this course is, therefore, estimated as 10 months (which is the length of time between assignment date of 1 Dec., 1987 and the course completion date of 27 Sep., 1988). The Waiting Time for the other courses is estimated in the same way.

The estimated training cost for each MOS course is obtained from the Marine Corps Cost Factors Manual [Ref. 8] and information received from HQMC directly. Two of the estimated training costs could not be obtained and for that reason somewhat arbitrary numbers have been used in this study for the training courses of MOS 0840 and MOS 0845.

The estimated training cost and waiting time for each MOS course are shown in Table 1.

TABLE 1
TRAINING COSTS AND WAITING TIME

MOS	Training Cost(TC)	Waiting Time(WT)
0802	$28582	10 Months
0803	$6057	9 Months
0840	$20000	9 Months
0845	$15000	4 Months
1802	$63485	9.5 Months
1803	$5732	3 Months

The OJT Cost (OJTC) will be computed as follows,

$$OJTC = TC + 6*AS$$

The idea behind this formula is that if the waiting time is longer than six months for any MOS course, assigning the officer without required training should be the preferred choice.

In this case OJTC is the MOS substitution cost which occurs when assigning an officer to a billet without formal training. OJTC is the perceived cost of filling a billet without formal training as compared to a perfect fit.

If none of the PMOS, AMOS1, or AMOS2 fit the BMOS but at least one of them is within the same OCCFLD as the BMOS, then the lower of the TRC and OJTC will determine the C_1 cost :

$$C_1 = \min(TRC, OJTC).$$

If none of the PMOS, AMOS1 and AMOS2 is within the same OCCFLD as the BMOS, then C_1 will be determined as follows:

$$C_1 = TRC + 50{,}000$$

In this case, OJT will not be considered as an assignment option, because it is not allowed by the Marine Corps. An additional cost of $50,000 is added to the training cost in this case, because assigning an officer outside his OCCFLD should be the last assignment option when compared to grade substitution or training another officer within the same OCCFLD as the BMOS.

In general, the MOS cost function considers the perceived cost of filling a billet with a MOS substitution as compared to with a perfect MOS fit.

In the Marine Corps, an officer can carry up to two AMOS's. If an officer already has two AMOSs, he can not be considered for training. In the assignment process, only officers with "AMOS1 = 0" or "AMOS2 = 0" should be considered for training.

In the record of officers,

"AMOS1 = 0" means the officer has no AMOS

"AMOS2 = 0" means the officer has at most one AMOS.

In summary,

$$C_1 = \begin{cases} 0 & \text{if PMOS = BMOS} \\ 1000 & \text{if PMOS} \neq \text{BMOS but AMOS1 or AMOS2 = BMOS} \\ \min(TRC, OJTC) & \text{if PMOS} \neq \text{BMOS, AMOS1} \neq \text{BMOS, AMOS2 = 0, but at least one is within the same OCCFLD as the BMOS.} \\ TRC + 50000 & \text{if none of the PMOS, AMOS1, AMOS2 is within same OCCFLD as the BMOS.} \end{cases}$$

At the beginning of this study a cost of $5000 was determined as C_1 if the PMOS does not fit the BMOS but one of the AMOSs fits the BMOS. Then C_1 was changed to $1000 under this condition, because filling a billet with an officer due to his AMOS should be a preferred option to assigning an officer due to his PMOS to that billet if it requires moving him more than 1000 miles.

2. **Grade Cost (C_2)**

In general, the cost function C_2 , considers the cost of filling a billet with grade substitution as compared to the cost of a perfect grade fit.

C_2 is determined by comparing the officer's grade(GR) with the billet grade(BGR), that is,

$$C_2 = f(GR,BGR).$$

If the GR and the BGR are an exact fit, a cost of zero is determined as the value of C_2 .

According to Marine Corps assignment rules, an officer may be assigned to a one grade higher billet. In this case a cost of $3,000 is determined as the value of C_2 . Also, according to Marine Corps general assignment rules only officers of grade O2 may be assigned to a one grade lower billet. In this case a cost of $4,000 is determined for C_2 .

An officer may not be assigned to a two or more grade higher or lower billet as an assignment rule. Therefore a high cost of $200,000 is determined for C_2 in this case as a penalty cost.

In summary,

$$C_2 = \begin{cases} 0 & \text{if GR = BGR} \\ 3000 & \text{if GR = BGR-1} \\ 4000 & \text{GR = O2 and BGR = WO} \\ 200000 & \text{for other possibilities.} \end{cases}$$

Also, at the beginning of this study a cost of $10,000 was determined for assigning an officer to a one grade higher billet and a cost of $15,000 was determined for assigning an officer to a one grade lower billet. These values have been changed however to $3,000 and $4,000 respectively, because the PCS cost (C_3) was never high enough for comparisons to be made with grade substitution cost (C_2).

3. **PCS Cost (C_3)**

The only real cost in the total cost formulation is the PCS cost (C_3) which is expressed as

$$C_3 = f(MILE,GR,DEP,DEP1,DEP2,MRS)$$

where

MILE = Mileage between the CCC and the BCCC,

DEP = Number of dependents of the officer to be assigned,

DEP1 = Number of dependents of age under 12,

DEP2 = Number of dependents of age over 12,

MRS = Marital status.

The PCS cost (C_3) will be computed as an additive function of four different costs. These are:

DLA : Dislocation allowance,

TE : Travel expenses,

PDA : Per diem allowances,

HSE : Household goods shipment expenses.

Then,

C_3 = DLA + TE + PDA + HSE

The explanations of these costs are as follows:

a. Dislocation Allowance (DLA)

Dislocation allowance is the equivalent of one month's basic allowance for quarters [Ref. 9] and [Ref. 10]. It depends on the grade and whether the officer has dependents. An officer with dependents automatically gets DLA. Officers without dependents are also eligible for DLA if government quarters are not available. In the cost formulation, we will assume that the officers are eligible for DLA. DLA rates are shown in Table 2.

TABLE 2
DISLOCATION ALLOWANCES (DLA)

Pay Grade	Without Dependent	With Dependent
WO	$336.8	$416.5
O1	$253.2	$343.2
O2	$295.2	$382.8
O3	$366.6	$446.4
O4	$452.7	$535.5
O5	$493.8	$585.9

Source : Ref 9 .

b. Travel Expences (TE)

Travel expenses will be computed as follows:

TE = MILE * MILERATE ,

where,

MILERATE = Total mileage reimbursement rate ($ per mile).

MILERATE is equal to the total allowance for the officer and his dependents. MILERATE for an officer is $.15currently. For each dependent the officer gets an additional MILRATE of $.02 subject to a maximum of $.05 for all dependents.

MILRATE = min (.20, .15 + DEP * .02).

c. Per Diem Allowances (PDA)

Current per diem rates are as follows:

Per diem for the officer (DIEMSP) = $50 per day.

Per diem for a dependent of age over 12 (DIEMGR) = $37.5 per day.

Per diem for a dependent of age under 12 (DIEMLT) = $25 per day.

Then, total per diem rate will be computed as follows:

PER DIEM RATE = DIEMSP + DIEMGR*DEP2 + DIEMLT*DEP1

Then the PDA will be computed by multiplying per diem rate by the number of days traveled:

PDA = Per Diem Rate * DAYS.

The number of days traveled (DAYS) is a function of the mileage between CCC and MCCC and will be computed as follows for the cost formulation:

DAYS = {MILE/350 + .5},

where{X} = largest integer $\leq$ X.

d. Household Goods Shipment Expences (HSE)

The military member and his dependents are authorized the shipment of household goods. The government covers the shipment cost of household goods.

Included among shipment costs are such costs as temporary storage cost, warehouse handling cost, packing and transportation costs. Among these only the last two will be considered for the cost formulation, for keeping the formulas simple. The other costs are small enough that they don't make much of a difference during the assignment process.

The household goods shipment expense is a function of the weight of the household goods and the mileage between the two locations. There is a maximum weight allowance for each grade [Ref. 11] as shown in Table 3 for which the government covers the shipment cost of household goods.

TABLE 3
HOUSEHOLD GOODS WEIGHT ALLOWANCE

Grade	Limit
O-1 W-1	9500 lbs.
O-2 W2	10000 lbs.
O-3 W3	11000 lbs
O-4 W-4	12000 lbs.
O-5	13000 lbs.
O-6	13500 lbs.

In the formulation the average weight of household goods shipped during the permanent change of station travel will be used as obtained from [Ref. 12]. These average weights for each grade are as shown in Table 4.

TABLE 4
AVERAGE WEIGHTS SHIPPED BY RANK

Grade	Avg. Weight
WO	5763 lbs.
O2	4057 lbs.
O3	6287 lbs.
O4	8151 lbs.
O5	8867 lbs.

Source : Ref 12 .

Packing cost rates (PCR) of per hundred pound household goods differ among geographical locations [Ref. 13]. But in the formulation $15.35 will be used as a

constant packing rate for all geographical locations for weights over 4000 pounds of household goods i.e. PCR = 15.35. Also, shipment cost rates (SCR) of per hundred pounds of household goods are different for each weight category and distance traveled. The following formulas will be used to compute shipment cost rates of two different weight categories in this study.

For 4000-7999 lbs. of household goods the shipment cost rate is:

SCR = 15 + (MILE 100) * 1.5

For 8000-11999 lbs. of household goods the shipment cost rate is:

SCR = 12 + (MILE 100) * 1.5

Then total household goods shipment expense (HSE) is computed as follows:

HSE = WTH * (PCR + SCR).

where

WTH = Average weight of household goods (in hundred pounds).

C. DATA

The following data files have been made use of for this study:

1. Marine Corps Artillery and Armor Officer Inventory Data

These data are an extract of Department of Defense individual officer data. Data include the following items: PMOS, AMOS1, Pay Grade, MCC, Marital Status, Number of Dependents, Number of Dependents of Age over 12, Number of Dependents of Age Under 12. The data were obtained from Defense Manpower Data Center (DMDC). The data don't include the AMOS2, because it was not available to the DMDC.

2. Marine Corps Artillery and Armor Billet Data

These data are an extract of the Marine Corps Authorized Strength Report which shows where all the Marine Corps (Artillery and Armor) officer billets are. Data include the BMOS, BGR, Billet Monitor Command Code (BMCC) and number of requirements for each billet.

3. CCC Table

The mileage between every two Cost Code Centers (CCC) is listed in this file.

4. CCC-MCC Convert Data

These data show the MCCs belonging to each CCC.

5. **Salary Data**

These data show the average salary of officers in each grade.

6. **DLA Data**

These data show the DLA rates for officers in each grade depending on whether he has dependents or not.

7. **Household Goods Weights Data**

These data show the average weights of household goods shipped during the PCS moves of officers of each grade.

III. ANALYSIS

In this study assignments of Marine Corps artillery and armor officers to billets in those two categories are analyzed.

In the inventory data, there are 1625 artillery and armor officers to be considered in filling the 1038 artillery and armor billets. The distribution of the artillery and armor officers by grade and PMOS is as shown in Table 5.

TABLE 5
DISTRIBUTION OF INVENTORY DATA

PMOS	Pay Grade					
	WO	O2	O3	O4	O5	Total
0802	1	386	371	221	128	1107
0803	17	-	-	-	-	17
1802	1	105	118	57	39	320
1803	-	72	64	31	14	181

Since in the inventory data we have only one AMOS, the distribution of AMOS1s only is shown in Table 6.

On the other hand, we assumed here that the 1042 artillery and armor billets must be filled by these officers only. Of the billets considered here 783 are artillery and 259 are armor billets. The distribution of the billets by grade and MOS is shown in Table 7.

A. METHOD OF ANALYSIS

The assignment problem is formulated as a type of a capacitated transportation model by Liang [Ref. 3]. In this study, a general form of the capacitated transportation model has been used for the analysis.

TABLE 6
DISTRIBUTION OF THE AMOSI

MOS	WO	O2	O3	O4	O5	Total
0802	3	-	-	-	-	3
0803	-	13	10	3	2	28
0840	-	2	5	5	4	16
0845	-	4	-	2	1	7
1802	-	-	6	9	2	17
1803	-	-	3	4	7	14

TABLE 7
DISTRIBUTION OF BILLETS

MOS	WO	O2	O3	O4	O5	Total
0802	-	427	159	108	48	742
0803	27	-	-	-	-	27
0840	-	2	3	3	2	10
0845	-	4	-	-	-	4
1802	-	79	26	31	10	146
1803	-	56	21	28	8	113

Figure 3.1 shows the network representation of the capacitated transportation model of Liang modified for this case.

In this figure the P nodes (P_1, P_2, . . . ,P_m) represent the officers to be assigned, the V nodes (V_1,V_2, . . . , V_n) represent the billets to be filled, V_{n+1} represents the dummy demand node for the unspecified billets, S represents the initial supply node, and D represents the final demand node.

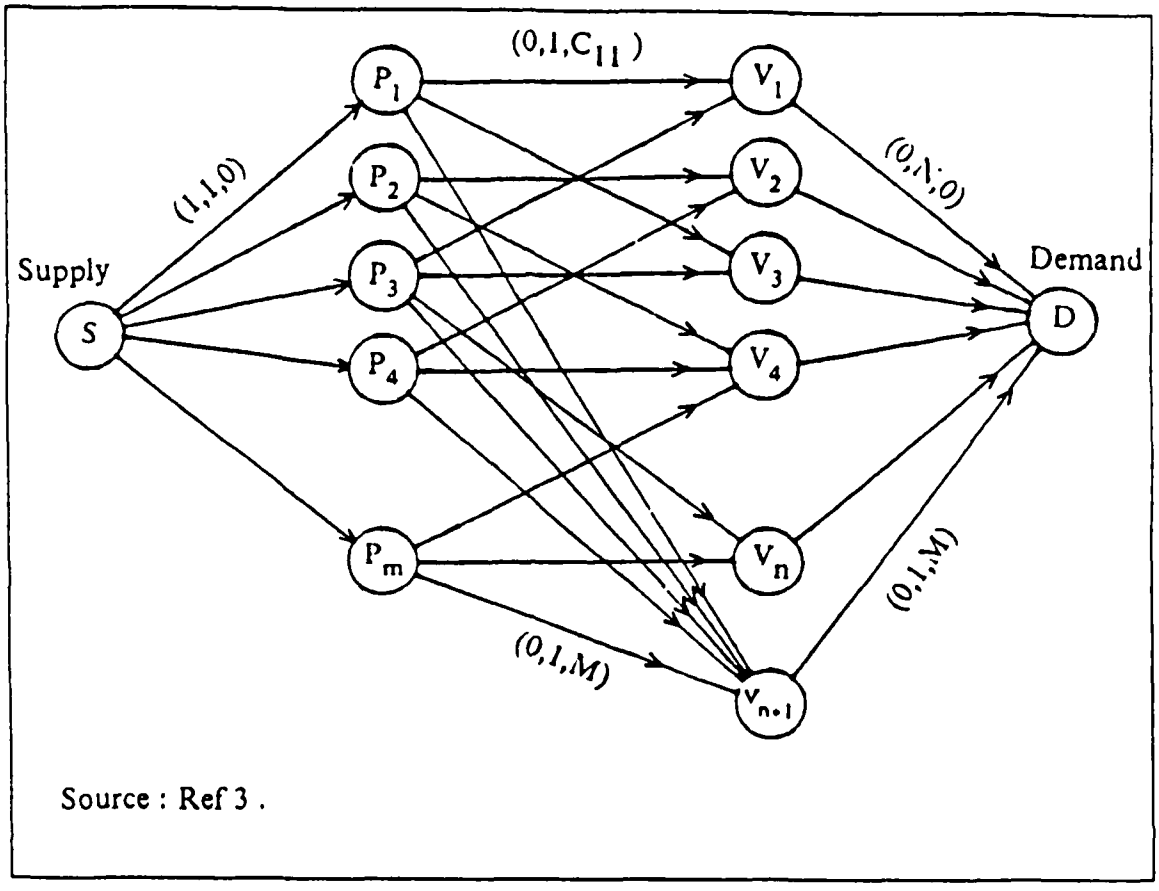

Figure 3.1 Genaral Form of Capacitated Transportation Model.

Arcs between P and V nodes show the feasible assignments. If there is not an arc between a P_i and a V_j node it means assignment between them is not feasible, in other words, the ith officer is not eligible for filling the jth billet.

The numbers in the parentheses over each arc represent the lower capacity, the upper capacity and the cost of assignment along each arc.

Two computer programs written in FORTRAN 77 and the GNET large scale network problem solver [Ref. 14] have been used for the analysis.

The first program (listed in Appendix A) computes the total cost for feasible assignment arcs. This program can be used to compute the costs C_1 , C_2 and C_3 separately as well as the distance between the CCCs for possible assignments. Also, this program can be used to review possible assignments by taking a specific inventory data and a set of billets with the associated costs for each possible assignment.

A second program (listed in Appendix B) creates data for the GNET cost minimization packages. In fact, this program is a continuation of the first program with some additions. This program aggregates billets which have the same BMOS, BGR and BCCC into demand nodes and regards each officer as a supply node. It is difficult to aggregate officers into supply nodes because of the complexity of the attributes DEP, DEP1, DEP2 and MRS. Costs of possible assignments are determined as the total cost as computed by the first program. Three additional nodes mentioned above, are created by this program. First, there is the dummy demand node, V_{n+1}, to which the inventory of officers must go. For the GNET cost minimization package, initial supply has to be equal to the final demand. This usually necessitates a dummy demand node to which supplies not otherwise assigned are sent and a dummy supply node from which supplies are sent to demand nodes not otherwise satisfied. In the data used here the officers outnumber the billet requirements. Therefore, only a dummy demand node has been created. The dummy supply node is not needed to analyze the data. Also, there is an initial supply node, S, and a final demand node, D.

Costs from the initial supply node, S, to the supply nodes, $P_1, \ldots, P_m$, from the supply nodes to the dummy demand node, V_{n+1}, and from the demand nodes, $V_1, \ldots, V_n$, to the final demand node, D, have been assigned zero cost in this program. Also, all capacities of arcs are determined as one, except for arcs between demand nodes and the final demand node and between the dummy demand node and the final demand node. The capacity of arcs between the demand nodes and the final demand node is the number of billet requirements. The capacity of the arc between the dummy demand node and the final demand node, D, is high enough that any excess number of officers can flow through it.

B. ANALYSIS OF THE DATA

Comparing the inventory and billet data, the only problem seems to be that the MOS 0802 grade O2 combination is short. There are 386 officers in the MOS 0802 grade O2 combination and there are 427 billets to be filled. It is impossible to fill this MOS grade combination even with grade substitution or by considering officers' AMOSs. According to the formulation method which was introduced in Chapter II, some of the MOS 1802 grade O2 and MOS 1803 grade O2 officers should be considered to fill these billets. Because waiting time for the MOS 0802 courses is 10 months, this MOS grade combination will be filled by assigning MOS 1802 grade O2 and MOS 1803 grade O2 officers to these billets without sending them to the MOS

course. In other words, these billets will be filled by officers getting on-the-job training. In this case, officers outside the OCCFLD 08 have been chosen for the training, because there are no available officers within the same OCCFLD for training.

Further, MOS 0803 grade WO, MOS 0840 grade O2 and MOS 0845 grade O2 combinations are also short because of the shortages in the MOS 0802 grade O2 combination. These billets could be filled by considering AMOSs of the MOS 0802 grade O2 officers. Because of the shortages in the MOS 0802 grade O2 combination and the relatively high cost of this MOS course, additional training (formal training or on-the-job training) will be needed to fill the MOS 0803 grade WO, MOS 0840 grade O2 and MOS 0845 grade O2 billets. Interestingly, while there are training needs for MOS 0803 grade WO combination, three of the MOS 0803 grade WO officers should be assigned the MOS 0802 grade O2 billets with their AMOSs (which is 0802), because the training cost of the MOS 0802 is high compared to training cost of the MOS 0803 even with grade substitution cost and PCS cost.

All the other billets will be filled by perfect MOS grade fit or by grade substitution depending on total cost of assignment when minimizing the cost.

C. ANALYSIS UNDER DIFFERENT ASSUMPTIONS

The purpose here is to simulate conditions the Marine Corps is facing in the real assignment process. This is necessary because the only officers and billets considered in this study are those in the 08 and 18 OCCFLD.

The assumptions analyzed are the following:

1. **Changes in the Assignment Rules.**

In the Marine Corps, assignment of O3, O4 and O5 grade officers to one grade lower billets is not permitted. But if grade O3 officers could be considered to fill O2 billets, all the billets would be filled by either perfect MOS grade fit or by grade substitution. Under such circumstances there would be no training requirements. Therefore, the Marine Corps could save money by permitting the assignment of O3 officers to O2 billets.

2. **Shortages at the O3, O4 and O5 grades**

This analysis was carried out to see what would be the optimal solution if the distribution of officers with MOS 0802 were as given in Table 8. In this case the MOS 0802 grade O3, O4 and O5 combinations would be short, even though the total number of officers in MOS 0802 are more than sufficient to fill all 0802 billets.

TABLE 8
CHANGES IN THE DISTRIBUTION OF MOS 0802

PMOS	Pay Grade					
	WO	O2	O3	O4	O5	Total
0802	0	470	140	100	40	750

Because assigning an officer to a one grade higher billet is permitted, all the billets will be filled by either perfect MOS grade fit or by grade substitution. Shortages in the grades O3, O4 and O5 will be filled by grade substitution. Shortages in MOS 0803, MOS 0840 and MOS 0845 billets will be filled by considering AMOSs of MOS 0802 officers. There will be no training requirements.

3. **Shortages in the Total Number of Officers in a MOS**

This analysis was carried out to see what would be the optimal solution if the distribution of officers with MOS 1802 were, as given in Table 9. In other words, in addition to the previous situation the total number of officers in MOS 1802 is also short.

TABLE 9
CHANGES IN THE DISTRIBUTION OF MOS 1802

PMOS	Pay Grade					
	WO	O2	O3	O4	O5	Total
1802	0	70	20	28	8	126

If we analyze the inventory and billet data under this condition, we see that training is required to fill all the MOS 1802 billets. According to the results of the analysis, 9 of the MOS 1803 grade O2 officers are required to undergo on-the-job training in this case. Other billets of this type have been filled by grade substitution or by considering the AMOSs of the MOS 1803 officers.

D. GENERAL RESULTS OF THE ANALYSIS

1. It has been found that training costs (formal training or on-the-job training) for MOS courses are very high compared to PCS costs (C_1) and grade substitution costs (C_2). Training cost should come into account only if one of the MOS grade combinations is short and it is impossible to fill such billets even with grade substitution. As a result, filling such billets with perfect MOS grade fit or with grade substitution at any PCS cost should be the preferred choice to additional training.
2. Assigning an officer to a billet with his AMOS should be the preferred choice compared to moving an officer 1000 miles or more to assign him with his PMOS. In fact,in practice it is possible that assigning an officer with his AMOS might be the preferred choice, anyway. For example, if an officer has more experience in his AMOS, or if currently he has a duty assignment due to his AMOS then the Marine Corps might prefer to assign him again using his AMOS.
3. There is a small cost difference between married and single officers for assigning them under similar conditions, because single officers can be moved more distance with less cost. In the formulation, it is assumed that single and married officers have the same amount of household goods to be shipped during a PCS move. For this reason the difference in the PCS cost is not as big as it is in practice.
4. Filling a billet with an officer by assigning him to a one grade higher billet within the same CCC should be the preferred choice to moving another officer more than 2500 miles to fill the same billet with a perfect grade fit.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This study has introduced a cost formulation method for officer assignments for the United States Marine Corps which may allow making comparisons among PCS cost, training cost and substitution cost by detailers. The main objective of this cost formulation method is to develop the least costly assignment plan.

In this study a prototype analysis has been made using Marine Corps artillery and armor officers and billets to test this cost formulation method. Because this study includes only artillery and armor officers as the possible alternatives in the assignment process, it can only serve as a prototype to show what type of cost comparisons could be integrated into a full-scale assignment model.

Also, some additional analysis has been carried out under some arbitrary assumptions. Because, this study does not include all the Marine Corps officers and billets, some problems of shortages have only been simulated by artificially changing the actual number of Artillery and Armor officers.

Even so, many problems of the actual assignment process have not been considered here. It is not possible in a mathematical model to capture all the factors used in the assignment of the officers. For example, many important but less easily quantifiable criteria, such as career patterns and past performance of officers must be considered by detailers in the actual assignment process. Therefore, this study may serve only as a prototype to make the cost comparison of the PCS cost, the training cost and the substitution cost. A full-scale assignment model based on the ideas introduced in this study and including the entire Marine Corps Officer Corps and its billets could serve as a decision support system for personnel assignments.

B. RECOMMENDATIONS

This study merely attempted to show the feasibility of comparison of the three costs (training, PCS and substitution) that have an impact on the assignment process. Therefore, it would be extremely useful to carry out a more thorough study of each of these three cost factors.

MOS training costs should be updated and more accurately assessed for each MOS course.

Grade substitution cost (C_2) should be reviewed. The cost of assigning an officer to a one grade higher billet and to a one grade lower billet should be computed in accordance with the changing policies of the Marine Corps.

The PCS cost (C_3) formula presented in Chapter II gives the approximate PCS cost within $500 of the actual cost. This cost formula could be reformulated even more accurately. Also, more detailed statistical values are needed for the average weights of household goods shipped during PCS travel.

With the above improvements cost comparisons could be made more reliably in a full-scale Marine Corps Officer Corps model for personnel assignments.

APPENDIX A
PROGRAM COST

```
C      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C      *   THIS IS A FORTRAN 77 PROGRAM THAT COMPUTES THE TOTAL  *
C      *            COST AS EXPLAINED IN CHAPTER 2.              *
C      * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
       PROGRAM THESIS
       PARAMETER (N=1625,K=283,L=2014,J=63,M=5)
       INTEGER*4 PMOS,AMOS,GR,DEP,DEP1,DEP2,BMOS,BGR,
      1BN,DIST,POF1,POF2,BOF,HHGWT,C1,A,B,C2,C3,
      2SAL1,SAL,COST1,TRC,TC,OJTC,
      3C,D,DAYS1,HHGWT1,NUM,MILE
       REAL  DLAWOD,DLAWD,DMRATE,MLRATE,DAYS,DIEM,
      1DLA1,COST,SCR,WT
       CHARACTER*3 MCC,BMCC,BCC
       DIMENSION PMOS(N),AMOS(N),GR(N),MCC(N),DEP(N),
      1DEP1(N),DEP2(N),BMOS(K),BGR(K),BMCC(K),NUM(K),
      2BN(L),BCC(L),DIST(J,J),POF1(N),POF2(N),BOF(K),
      3SAL(M),DLAWOD(M),DLAWD(M),HHGWT(M),COST1(N,K)
       CALL EXCMS ('FILEDEF 01 DISK INVEN DATA A1')
       CALL EXCMS ('FILEDEF 02 DISK BILLET DATA A1')
       CALL EXCMS ('FILEDEF 03 DISK CCC-MCC CONVERT A1')
       CALL EXCMS ('FILEDEF 04 DISK COST-CTR DIST-MAT A1')
       CALL EXCMS ('FILEDEF 08 DISK SALARY DATA A1')
       CALL EXCMS ('FILEDEF 09 DISK DLA DATA A1')
       CALL EXCMS ('FILEDEF 10 DISK HHGWT DATA A1')
       CALL EXCMS ('FILEDEF 28 DISK COST OUTPUT A1')
       READ(01,11) (PMOS(I),AMOS(I),GR(I),MCC(I),DEP(I),DEP1(I),
      1DEP2(I),POF1(I),POF2(I),I=1,N)
   11 FORMAT(I4,I4,2X,I1,1X,A3,I1,I1,I1,TL18,I2,2X,I2)
       READ(02,12) (BMOS(I),BGR(I),BMCC(I),NUM(I),BOF(I),I=1,K)
   12 FORMAT(I4,1X,I1,A3,19X,I2,TL29,I2)
       READ(03,13) (BCC(I),BN(I),I=1,L)
   13 FORMAT(6X,A3,1X,I2)
       READ(04,14)  ((DIST(I,A),I=1,J),A=1,J)
   14 FORMAT(I4)
       READ(08,15) (SAL(I),I=1,M)
   15 FORMAT(I4)
       READ(09,16) (DLAWOD(I),DLAWD(I),I=1,M)
   16 FORMAT(F5.1,2X,F5.1)
       READ(10,17) (HHGWT(I),I=1,M)
   17 FORMAT(I2)
*  COST CALCULATIONS
       DO 20 A=1,N
       DO 21 B=1,K
*  COST CALCULATIONS
*  CALCULATE GRADE COST (C2)
       IF (GR(A) .EQ. BGR(B)) THEN
       C2=0
       ELSE IF (GR(A) .EQ. (BGR(B)-1)) THEN
       C2=3000
       ELSE IF ((GR(A) .EQ. (BGR(B)+1)) .AND. (GR(A) .EQ. 2))THEN
       C2=4000
       ELSE
       GO TO 21
       END IF
*  CALCULATE MOS COST (C1)
       IF (PMOS(A) .EQ. BMOS(B)) THEN
       C1=0
       ELSE IF (AMOS(A) .EQ. BMOS(B)) THEN
       C1=1000
       ELSE
       C1=200000
```

```
        END IF
        IF (C1 .GE. 200000) THEN
             IF (BMOS(B) .EQ. 0802) THEN
             TC=28500
             WT=9
             ELSE IF(BMOS(B) .EQ. 0803) THEN
             TC=6056
             WT=8
             ELSE IF (BMOS(B) .EQ. 0840) THEN
             TC=20000
             WT=9
             ELSE IF (BMOS(B) .EQ. 0845) THEN
             TC=15000
             WT=8
             ELSE IF (BMOS(B) .EQ. 1802) THEN
             TC=63485
             WT=5
             ELSE IF (BMOS(B) .EQ. 1803) THEN
             TC=5732
             WT=4
             END IF
            IF ((POF1(A) .EQ. BOF(B)) .OR. (POF2(A) .EQ. BOF(B))) THEN
             SAL1 = SAL(GR(A))
            TRC=TC+(WT*SAL1)
            OJTC = TC+(6*SAL1)
            IF (TRC .GE. OJTC) THEN
            C1=OJTC
            ELSE
            C1 = TRC
            END IF
            ELSE
            C1=TC + 50000
            END IF
        END IF
        DO 22 C=1,L
        IF (MCC(A) .EQ. BCC(C)) GO TO 23
    22 CONTINUE
    23 DO 24 D=1,L
        IF (BMCC(B) .EQ. BCC(D)) GO TO 25
    24 CONTINUE
    25 MILE=DIST(BN(C),BN(D))
        IF (MILE .LT. 80 ) THEN
        C3=0
        ELSE
* CALCULATE MILEAGE RATE
        IF (DEP(A) .GE. 3 ) THEN
        DMRATE = .05
        ELSE
        DMRATE = .02 * DEP(A)
        END IF
        MLRATE = .15 + DMRATE
*      CALCULATE DAYS
        DAYS = MILE / 350 + .5
        DAYS1=ANINT (DAYS)
*      CALCULATE DIEM RATE
        DIEM=50+(37.5*DEP2(A))+(25*DEP1(A))
*CALCULATE DLA RATE
        IF (DEP(A) .GT. 0 ) THEN
        DLA1=DLAWD(GR(A))
        ELSE
        DLA1=DLAWOD(GR(A))
        END IF
        HHGWT1=HHGWT(GR(A))
        IF (HHGWT1 .LE. 79) THEN
        SCR=15+((MILE/100)*1.5)
        ELSE
        SCR=12+((MILE/100)*1.5)
        END IF
        COST=DLA1+(MILE*MLRATE)+(DAYS1*DIEM)+(HHGWT1*SCR)
        C3=ANINT(COST)
```

```
      END IF
      COST1(A,B)=C1+C2+C3
      WRITE (28,103) A,B,COST1(A,B),MILE,DEP(A),GR(A),BGR(B),
     1PMOS(A),BMOS(B),C3
  103 FORMAT (I3,2X,I3,2X,I6,2X,I4,2X,I1,2X,I1,2X,I1,2X,I4,2X,I4,2X,I5)
   21 CONTINUE
   20 CONTINUE
      STOP
      END
```

APPENDIX B
PROGRAM GNET

```
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     *   THIS IS A FORTRAN 77 PROGRAM THAT CREATES AN OUTPUT *
C     *         DATA FOR GNET COST MINIMIZING PACKAGES.       *
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C     * * * * DEFINITION OF KEY VARIABLES * * * * * * * * * * * *
C     * PMOS     : EACH OFFICER'S PRIMARY JOB QUALIFICATION.   *
C     * AMOS     : ADDITIONAL MOS.                             *
C     * GR       : THE GRADE OF THE OFFICER.                   *
C     * DEP      : NUMBER OF THE DEPENDENTS OF THE OFFICER.    *
C     * DEP1     : NUMBER OF DEPENDENTS OF AGE UNDER 12.       *
C     * DEP2     : NUMBER OF DEPENDENTS OF AGE OVER 12.        *
C     * BMOS     : BILLET MOS REQUIREMENT.                     *
C     * BGR      : BILLET GRADE REQUIREMENT.                   *
C     * MILE     : MILEAGE BETWEEN CCC AND BCCC.               *
C     * POF1     : OFFICER'S OCCFLD WITH HIS PMOS.             *
C     * POF2     : OFFICER'S OCCFLD WITH HIS AMOS.             *
C     * BOF      : OCCLFD OF THE BILLET.                       *
C     * HHGWT    : AVERAGE WEIGHT OF THE HOUSEHOLD GOODS.      *
C     * DAYS1    : NUMBER OF DAYS TRAVELED.                    *
C     * SAL      : AVERAGE SALARY OF THE OFFICER.              *
C     * TRC      : TOTAL TRAINING COST.                        *
C     * TC       : ESTIMATED COST OF THE MOS COURSES.          *
C     * WT       : WAITING TIME FOR EACH MOS COURSES.          *
C     * OJTC     : ON THE JOB TRAINING COST.                   *
C     * NUM      : NUMBER OF BILLET REQUIREMENT.               *
C     * DLAWD    : DLA RATE WITH DEPENDENTS.                   *
C     * DLAWOD   : DLA RATE WITHOUT DEPENDENTS.                *
C     * DMRATE   : TOTAL DIEM RATE.                            *
C     * MLRATE   : TOTAL MILEAGE RATE.                         *
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
      PROGRAM GNET
      PARAMETER (N=501,K=117,L=2014,J=63,M=5)
      INTEGER*4 PMOS,AMOS,GR,DEP,DEP1,DEP2,BMOS,BGR,
     1BN,DIST,POF1,POF2,BOF,HHGWT,C1,A,B,C2,Z1,Z2,Z3,Z4,Z5,
     2TRC,TC,S,WT,OJTC,SAL1,SAL,W,W1,W2,COST1,NUM,F,X,X1
     3C,D,DAYS1,HHGWT1,TOTNUM,MILE
      REAL   DLAWOD,DLAWD,DMRATE,MLRATE,DAYS,DIEM,C3,
     1DLA1,COST,SCR
      CHARACTER*3 MCC,BMCC,BCC
      DIMENSION PMOS(N),AMOS(N),GR(N),MCC(N),DEP(N),
     1DEP1(N),DEP2(N),BMOS(K),BGR(K),BMCC(K),NUM(K),
     2BN(L),BCC(L),DIST(J,J),POF1(N),POF2(N),BOF(K),
     3SAL(M),DLAWOD(M),DLAWD(M),HHGWT(M),COST1(N,K)
      CALL EXCMS ('FILEDEF 01 DISK INVEN DATA A1')
      CALL EXCMS ('FILEDEF 02 DISK BILLET DATA A1')
      CALL EXCMS ('FILEDEF 03 DISK CCC-MCC CONVERT A1')
      CALL EXCMS ('FILEDEF 04 DISK COST-CTR DIST-MAT A1')
      CALL EXCMS ('FILEDEF 08 DISK SALARY DATA A1')
      CALL EXCMS ('FILEDEF 09 DISK DLA DATA A1')
      CALL EXCMS ('FILEDEF 10 DISK HHGWT DATA A1')
      CALL EXCMS ('FILEDEF 28 DISK TEC3 GNET T1')
      READ(01,11) (PMOS(I),AMOS(I),GR(I),MCC(I),DEP(I),DEP1(I),
     1DEP2(I),POF1(I),POF2(I),I=1,N)
   11 FORMAT(I4,I4,2X,I1,1X,A3,I1,I1,I1,TL18,I2,2X,I2)
      READ(02,12) (BMOS(I),BGR(I),BMCC(I),NUM(I),BOF(I),I=1,K)
   12 FORMAT(I4,1X,I1,A3,19X,I2,TL29,I2)
      READ(03,13) (BCC(I),BN(I),I=1,L)
   13 FORMAT(6X,A3,1X,I2)
      READ(04,14)  ((DIST(I,A),I=1,J),A=1,J)
   14 FORMAT(I4)
      READ(08,15) (SAL(I),I=1,M)
```

```
   15 FORMAT(I4)
      READ(09,16) (DLAWOD(I),DLAWD(I),I=1,M)
   16 FORMAT(F5.1,2X,F5.1)
      READ(10,17) (HHGWT(I),I=1,M)
   17 FORMAT(I2)
* COST CALCULATIONS
      TOTNUM=0
      DO 41 B=1,K
      TOTNUM=TOTNUM+NUM(B)
   41 CONTINUE
      DO 20 A=1,N
      DO 21 B=1,K
* COST CALCULATIONS
* CALCULATE GRADE COST
      IF (GR(A) .EQ. BGR(B)) THEN
      C2=0
      ELSE IF (GR(A) .EQ. (BGR(B)-1)) THEN
      C2=3000
      ELSE IF ((GR(A) .EQ. (BGR(B)+1)) .AND.
     1((GR(A) .EQ. 2) .OR. (GR(A) .EQ. 3)))  THEN
      C2=4000
      ELSE
      GO TO 21
      END IF
* CALCULATE MOS COST (C1)
      IF (PMOS(A) .EQ. BMOS(B)) THEN
      C1=0
      ELSE IF (AMOS(A) .EQ. BMOS(B)) THEN
      C1=1000
      ELSE
      C1=200000
      END IF
      IF (C1 .GE. 200000 ) THEN
           IF (BMOS(B) .EQ. 0802) THEN
           TC=28500
           WT=9
           ELSE IF(BMOS(B) .EQ. 0803) THEN
           TC=6056
           WT=8
           ELSE IF (BMOS(B) .EQ. 0840) THEN
           TC=20000
           WT=9
           ELSE IF (BMOS(B) .EQ. 0845) THEN
           TC=15000
           WT=8
           ELSE IF (BMOS(B) .EQ. 1802) THEN
           TC=63485
           WT=5
           ELSE IF (BMOS(B) .EQ. 1803) THEN
           TC=5732
           WT=4
           END IF
           SAL1 = SAL(GR(A))
          TRC=TC+(WT*SAL1)
          OJTC = TC+(6*SAL1)
          IF (TRC .GE. OJTC) THEN
          C1=OJTC
          ELSE
          C1 = TRC
          END IF
      END IF
*CALCULATE DISTANCE
      DO 22 C=1,L
      IF (MCC(A) .EQ. BCC(C)) GO TO 23
   22 CONTINUE
   23 DO 24 D=1,L
      IF (BMCC(B) .EQ. BCC(D)) GO TO 25
   24 CONTINUE
   25 MILE=DIST(BN(C),BN(D))
      IF (MILE .LT. 80 ) THEN
```

```
        C3=0
        ELSE
*  CALCULATE MILEAGE RATE
        IF (DEP(A) .GE. 3 ) THEN
        DMRATE=.05
        ELSE
        DMRATE=.02*DEP(A)
        END IF
        MLRATE=.15+DMRATE
*      CALCULATE DAYS
        DAYS=MILE/350+.5
        DAYS1=ANINT (DAYS)
*      CALCULATE DIEM RATE
        DIEM=50+(37.5*DEP2(A))+(25*DEP1(A))
*CALCULATE DLA RATE
        IF (DEP(A) .GT. 0 ) THEN
        DLA1=DLAWD(GR(A))
        ELSE
        DLA1=DLAWOD(GR(A))
        END IF
        HHGWT1=HHGWT(GR(A))
        IF (HHGWT1 .LE. 79) THEN
        SCR=15+((MILE/100)*1.5)
        ELSE
        SCR=12+((MILE/100)*1.5)
        END IF
        C3=DLA1+(MILE*MLRATE)+(DAYS1*DIEM)+(HHGWT1*SCR)
        END IF
        COST=C1+C2+C3
        COST1(A,B)=ANINT(COST)
        IF((A .EQ. 1) .AND. (B .EQ. 1)) THEN
        W=N+K+1
        W1=1
        W2=1
        WRITE(28,101) W,W1
  101 FORMAT(1X,I4,4X,I1)
        ELSE
        GO TO 102
        END IF
  102 F=N+B
C       IF (COST1(A,B) .LT. 15000) THEN
        WRITE (28,103) A,F,COST1(A,B),W2
  103 FORMAT (8X,I4,3X,I3,6X,I6,9X,I1)
C       ELSE
C       GO TO 21
C       END IF
   21 CONTINUE
   20 CONTINUE
        Z1=W+1
        Z2=Z1+1
        Z3=0
        Z4=N+1
        DO 33 I=1,N
        WRITE(28,105) I,W,Z3,W2
  105 FORMAT (8X,I4,2X,I4,6X,I6,9X,I1)
   33 CONTINUE
        DO 30 A=1,N
        WRITE(28,104) Z1,A,Z3,W2
  104 FORMAT(8X,I4,2X,I4,11X,I1,9X,I1)
   30 CONTINUE
        X=W-1
        X1=0
        DO 40 B=Z4,X
        X1=X1+1
        WRITE(28,107) B,Z2,Z3,NUM(X1)
  107 FORMAT(9X,I3,3X,I3,11X,I1,8X,I2)
   40 CONTINUE
        Z5=N-TOTNUM
        WRITE(28,106) W,Z2,Z3,Z5
  106 FORMAT(8X,I4,2X,I4,11X,I1,6X,I4)
```

```
STOP
END
```

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